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OF

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NOTES

ON THE

GEOLOGY OF NORTH SHROPSHIRE.

Charlotte Eyton.

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1869.

DEAR MR. SYMONDS,

As I do not think that this little work would ever have appeared in its present form without your encouragement and assistance, and as your suggestions have undoubtedly added much to whatever value it may possess, allow me to express my sense of your kindness by dedicating it to you, and believe me,

Yours sincerely,

CHARLOTTE EYTON.

July 1869.

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CHAPTER I.

INTRODUCTION.

MUTUAL INFLUENCE OF MECHANICAL AND GEOLOGICAL SCIENCE—OBJECT OF THE WORK—GENERAL PANORAMIC VIEW FROM THE SUMMIT OF THE WREKIN.

THE printing press is in these days the recognised organ of communication between fellow-workers in the same field. And it is a pleasant thought that all honest and faithful labourers, in whatever sphere, may by this means effect an interchange of ideas, and, though personally unknown to each other, may yet hold communion by means of their common tastes and sympathies.

Much good has been done in this way by the many popular magazines now so widely circulated among us. Indeed, it almost seems as if, in this instance, the well-known maxim that the demand creates the supply might be reversed, since whoever has once tasted of those limpid streams which flow from the fount of knowledge will certainly desire to partake more largely. The draught, to be satisfying, must be long and deep—long as human life, and deep as human intellect. And it is by the accretion of lives and intellects so spent that great results are arrived at. For the strength of those master minds, which seem to rise up whenever and wherever they are required, is shown, not so much in their individual efforts, as in their power of collecting and combining the labours of subordinate workers — as the force of attraction holds in cohesion the atoms of which the globe is composed.

There are two classes of workers, or rather two great principles of labour. One is the utilitarian principle, which, as soon as any new discovery is made, at once begins to consider what can be got out of it—what practical use it can be turned to: which holds that all labour is of value just in proportion to the substantial benefit which it confers upon the worker or upon others, and which enunciates the maxim, 'a fair day's wages for a fair day's work,' meaning by wages money or money's worth.

This is a just and a good principle in its way, and one which in these days cannot be disregarded. But there is a better and a higher. It is the love of labour for its own sake, not as a duty, but as a privilege, bringing its own payment, or rather, perhaps, not looking for payment at all, but rejoicing and glorying in its work, because it is a glad and glorious thing, delighting to lavish treasure, intellect, all good and precious gifts, upon what is itself so good and precious. This was the principle of the early Chaldean shepherds, as they kept their sheep upon the Eastern plains at night, and gazed upon the (to them) mysterious wanderings of the heavenly bodies, until, knowing no better, they bowed their heads and worshipped. It was the principle of the Greek philosophers, Pythagoras and Socrates; of the Roman Cicero and the Alexandrian Hypatia, striving to awaken a besotted and unworthy people to a sense of their own dead honour. It animated Michael Angelo, painting the roof of the Sistine chapel, with devotional love and awe in his work; Dante, striving against oppression, exiled, and, like the dying swan, breathing forth his pain in such sounds as the world has never heard, before or since; Christopher Columbus, laughed at, despised, sailing across the ocean to discover new worlds; Palissy, burning his household furniture in the china furnace; all were examples of this great principle, which has been the guiding star of all the really great artists, inventors, politicians, or labourers in any sphere, whom the world has ever seen.

It is a hopeful sign for England that there is so much of this spirit now abroad. It may be called the chivalry of labour; and it is more widely spread than the chivalry of the middle ages was at its brightest period; although it may not show so strongly, for that very reason, and because it has not so dark a background to throw it out. It shows itself in the immense amount of amateur work which is now carried on. Field clubs, night schools, debating societies, district visiting societies—all the best and highest kinds of work—are being done by unpaid labourers. I do not mean that funds are not required for these things. A hammer is a necessary implement to a geologist; but no one dreams of studying geology for the sake of possessing a hammer. Only let us take care that it is real work that we do, with all our strength, all our energy, not mere superficial trifling; and, whether it be mending roads, inventing steam engines, or studying the heavenly bodies, it will be true work, and will leave its stamp upon the world after the doer has perished and is forgotten.

Of all the many branches of science, there are none which have a closer mutual relation than geology and mechanics. When any great advance has been made in one, the other has always followed closely in its wake. What should we have known of the interior of the earth's crust, but for the excavations of miners? And how could these excavations have been carried on, without the adaptation of the mechanical powers to the requirements of engineering? Again, what facilities have been afforded to the geologist by the cuttings and tunnellings of the various railways which spread themselves, like veins and arteries, throughout the length and breadth of our land! But never would they have thus spread themselves, but for the application of steam to the purpose of locomotion. The use of steam as a motive power is a great era in the diffusion of knowledge. In the year 1774, James Watt completed his model steam engine, for pumping water out of the Cornish mines, and in the same year Charles Hutton was elected a member of the Royal Society. In 1815, William Smith published his large coloured map of the geology of England and Wales; and in 1816, George Stephenson took out a patent for locomotive steam engines, to be used in the collieries of Newcastle-upon-Tyne.

These considerations are peculiarly interesting to persons living, as we in North Shropshire do, upon the border of an extensive mining and colliery district. Almost contemporaneously with the last mentioned events, we find another application of steam power, which perhaps did more than any other to advance the progress of every kind of knowledge. On November 18, 1814, the 'Times' newspaper was printed for the first time by Messrs. Cowper and Applegath's steam press. Since then we have had, following each other in rapid succession, works of every degree of importance, from those of Hugh Miller, Lyell, Sedgwick, Murchison, and other generals of the scientific army, down to the small local guide books, whose chief use lies in the material which, if carefully and truthfully collected, they afford ready for the hands of more general labourers.

The following pages do not profess to give a complete or detailed account of the geology of the country they describe. They are simply, as the title imports, notes of geological work in the neighbourhood of the Wrekin and part of the plain of North Shropshire. It is hoped that they may be of some assistance to beginners in geology, or to strangers visiting the district; and also that they may afford an hour's pleasant reading to those who, without having the leisure or inclination for actual field-work themselves, are yet sufficiently interested in the wonders of the world around them to be desirous of making their acquaintance through the medium of other minds.

Before descending to the ground more immediately under consideration, it may be well to gaze, from the summit of the Wrekin, at the glorious panorama spread around us, and to take a short review of its more striking geological features.

On the SW. we see the Church Stretton valley, running from north to south, with the eruptive outbreaks of Caradoc and Lawley rising in the midst; while on the west of these the Cambrian grits of the Longmynd, 16,000 feet in thickness, extend themselves, until they pass into the Lingula flags and Stiper-stones, or Arenig group of Professor Sedgwick—the base of the Silurian system. From thence, further still to the west, we have the Llandeilo beds of Corndon and

Shelve. Returning to the Church Stretton valley, we have the whole of the Silurian beds, from the Caradoc sandstone to the Wenlock limestone, spread out at our feet in a beautiful and picturesque alternation of hill and valley, occasioned partly by upheaval, and partly by the action of denuding forces upon the softer beds, which alternate with the hard limestones, and upon the weak places afforded by lines of fault. Of this nature are the valleys of the Wenlock and Lower Ludlow shales, which have been denuded, leaving the ridges of Upper Llandovery, Wenlock and Aymestry limestone, standing bold and upright.

Following the Silurian beds to the south, we can barely distinguish the low hills of Upper and Middle Ludlow rock, on the Herefordshire border, which soon dip under the old red sandstone. This rock forms a sort of margin or outer circle to this part of the Silurian basin. It is strikingly visible in the Black mountains of Herefordshire, from whence it runs along to the Brown Clee-hill, where it passes conformably upwards into the yellow sandstone of the coal-measures, which is here very well developed. And here, and at Shirlet, in the neighbourhood of Bridgenorth, we have those little fragmentary coal-fields which speak so strongly in favour of a Permian epoch of denudation. Both these little fields repose conformably upon the old red system, whether we consider the yellow sandstone as an upper member of that system or, which seems to be its true position, as the base of the carboniferous beds.

On the east of the Wrekin we find the Coalbrookdale field spreading itself out to the north and east. As this is included in the extent of country to be afterwards more particularly considered, we will not now dwell upon it, but carrying the eye again a little to the S. of W. observe that part of the Shrewsbury coal-field, which lies at the base of Haughmond Hill, between that ridge and the Severn, and which, reposing upon a Cambrian flooring, is only separated from the coal-measures of Donnington Wood and Ketley, on the outskirts of the first mentioned tract, by a trough or plain of Lower Bunter sandstone, about nine miles in width. Whether this sandstone really forms a barrier or division between the two coal-fields, or whether they underlie it, and are in reality one field, it is impossible to do more than conjecture at present. A similar trough divides the Shropshire from the South Staffordshire coal-field, as may be seen in travelling by railway from Wellington to Wolverhampton.

Lastly, looking to the W. and NW. we have the extensive plain of the Bunter sandstone, reaching to the borders of North Wales, Cheshire, and Staffordshire. On the Cheshire border, it passes, as will be hereafter described, into the Lower Keüper beds, forming a range of low hills, generally with rounded summits, as at Pimhill, but breaking into a steep escarpment at the Clive. These are again overlaid by a small tract of inferior Lias.

The change from the Silurian scenery on the south bank of the Severn, to that of the new red sandstone on the north, is very remarkable and characteristic. The ever-varying outlines, the peaks and ridges, the ravines and glens of the former, stand in striking contrast to the level plain, rarely diversified by an outbreak of igneous rock, which marks the extent of the latter. And yet it is the same influence, acting upon a different surface, that has produced both. The denuding agent (supposing it to act evenly over the whole extent) which, working upon alternate beds of hard and soft rock, forms corresponding alternations of ridge and furrow, will when moving over an uniform surface, presenting no weak points, and everywhere equally susceptible to its influence, produce the effect of a perfectly level plain, removing the same proportion of substance in every part, and smoothing and rounding all inequalities that may previously have existed. The only agent which we know of that does act thus evenly is the sea. The effect of atmospheric denudation is generally to cause uneven depressions and furrows. Some of these exist in the plain now under consideration, and will be remarked upon in due course; but they are not of sufficient importance to break the general effect of the outline above described.

CHAPTER II.

DESCRIPTION OF THE COUNTRY MORE IMMEDIATELY UNDER CONSIDERATION—CAMBRIAN GRITS OF HAUGHMOND HILL—ALTERED DITTO, WITH INTERSTRATIFIED LAVAS.

THE country which we are now more immediately to consider, consists of stratified deposits, resting against the base of three principal volcanic ridges, running nearly parallel to each other. There are, indeed, four of these ridges, but that which lies second in order has its base almost entirely concealed by a thick covering of new red sandstone; and, as it belongs to the same period as the third and principal ridge, there is no occasion to do more than glance at it in this place.

These four ridges run (roughly speaking) from SW. to NE., all lying upon the northern bank of the Severn. The most westerly is Haughmond Hill, an outbreak of Cambrian age, associated with Harlech or Longmynd Grits. Then comes a basaltic outbreak, extending from Admaston Spa, through Wrockwardine, Leaton, and Burcott, Uppington, and Charlton Hill. This, as has been explained, is of little interest at present. Thirdly, we have the Wrekin Chain itself, reaching from the little syenitic mound of Ten Trees, or, as it is called in the Ordnance map, Primrose Hill, through the Wrekin, Lawrence's Hill, and the Ercall, representing the volcanoes of the Silurian epoch. This outbreak is by far the most important in appearance, as well as in its local effects. Lastly, we come to the carboniferous volcanic period, represented in the basalt of Maddox's Hill, east of the Ercall, and its prolongation southward, the Hatch bank.

To the north-west of the Wrekin then, at a distance of about seven miles, rises the long low terrace of Haughmond Hill, with its lower Cambrian grits and interstratified lavas. These beds belong to the same series as those of the Longmynd, from which they are cut off by an intervening corner of the Shrewsbury coal-field, coming in between the hill and the river. They reappear again a little to the south. The best way to examine them is to cross the hill by the Holly coppice, proceeding downwards to Haughmond Abbey, and then follow the strike of the beds to the south-eastern face of the hill, above Uffington, where the effects of metamorphism are visible.

Nearly at the summit of the hill, above the Abbey, there is a quarry where the rock should be observed in its unaltered state—that of a close-grained, hard, greenish-grey grit. Following the road, which in this place crosses the strike, we find the same beds continuing for about 40 yards, when there occurs a small dyke of dark red lava, the rock being unaltered both above and below the outbreak. Underlying it we find a coarse sandstone conglomerate, continuing for about 50 yards further, and containing numerous small round pebbles of quartz and syenite, apparently the washing-up of an angry sea upon the Cambrian beach. The whole of these beds dip to the NE. at an angle of 65°.

The sequence of events exhibited in this locality must have been something like this. First, an ocean, then as now, ceaselessly employed in removing materials from one situation and throwing them up in another in the form of drift; the material being chiefly derived from the erupted matter of submarine volcanoes. These beds having formed and hardened, a lava outburst spread itself in a thin sheet over them, preserving them from denudation and leaving their substance intact. This cooled down, and, the former beach having become a deep sea bottom, upon it were deposited the grey grits, which here attain a thickness of about 4,620 feet.

Ascending the hill we find that the upper edges of the beds, dipping at so steep an angle, form a flat terrace or table-land of considerable extent, covered with gorse and fern, and diversified by clumps of fir trees. Along this table-land there is a pleasant walk to the tower at the south-eastern point, on the left of which may be found another example of interstratified lava, but showing very different results from that above described. The beds of grit have been slightly faulted and contorted in the neighbourhood of the outbreak, forming in one place a miniature synclinal; and the denuding agents of later times, according to their invariable rule of working always on the weakest part, have here formed several deep ravines in the face of the hill, leaving the lava beds and those in immediate contact with them untouched. The effect of this contact upon the grits has been completely to change their substance, converting them from a sedimentary to a crystalline deposit. The series of gradations is complete. First, the grey tint of the grit is changed to purple, then it passes into a thin band of slate, and finally becomes a laminated purple shale, crystalline in structure, and roasted white at the point of actual contact with the lava. Specimens of each of the beds may be obtained from the rabbit-holes in the vicinity. These little excavators have carried on extensive operations through the bed of shale, which affords a soft place for them to work in. It is worth observing the manner in which this bed has been preserved from denuding influences by the overlying grit, while harder rocks in the neighbourhood must have been carried away.

The phenomenon of metamorphism is exhibited on a much larger scale in the Longmynd rocks in the Church Stretton Valley. The Cambrian rocks of Shropshire belong entirely to the Longmynd or Harlech and Barmouth group, lying at the base of the lower Cambrian series. Immediately above them is the Menevian group, in which Mr. Salter and Mr. H. Hicks have made such successful researches, near St. David's, in South Wales. Next comes the upper Cambrian series, and, above that, and the Lingula flags, the Arenig or Stiper-stones group, forming the base of the Silurian system in Shropshire.

CHAPTER III.

VOLCANIC ROCK OF THE WREKIN AND LAWRENCE'S HILL—PLUTONIC ROCK OF THE ERCALL—ALTERED ROCKS—SILURIAN BEDS IN THE NEIGHBOURHOOD OF THE WREKIN.

We have now described the most westerly of the four volcanic outbursts alluded to in the last chapter. Passing over the second, for the reasons there given, it will, in this, be our endeavour to picture the state of things which existed at the outbreak of the third, representing the second or Silurian period of volcanic activity.

The Wrekin Chain, extending for a distance of four miles from SW. to NE., is composed of rocks of varied appearance and character. The Wrekin itself and its little northern neighbour, Lawrence's Hill, consist of dark red lava, with veins of several different minerals. The quarry in this valley, at the foot of Lawrence's Hill, by the side of the road from Cluddeley to Little Wenlock, is a good locality to examine the different appearances of the lava with its encrustations. The joints occasioned by the contraction of the heated mass while cooling are visible in this quarry, but they are most apparent at a spot reached by climbing the hill for a short distance, just above where the roads from Wellington and Cluddeley join.

Following the Wellington Road, past Bukatre Hall farm, we arrive, in time, at the Ercall quarry. Here we perceive the nucleus of the hill to be formed of pink syenite—a Plutonic rock, or one supposed to have been cooled before it arrived at the surface, instead of flowing out in a liquid state. A similar rock forms the nucleus of Primrose Hill at the south-western extremity of the chain. Resting against this is a crystalline rock, which weathers grey, but where newly fractured is nearly white. It is from these two rocks that the red and white Ercall gravels are procured. The grey rock is much softer than the pink. It easily decomposes into a whitish paste. It is largely impregnated with ochre, which appears in red and yellow stains upon the surface. Green marks, apparently serpentinous, also occur in places. On the whole, this rock seems a good deal similar, both in character and position, to those crystalline masses which repose against the syenite of the Malvern Hills, and which Dr. Holl argues to be of lower Laurentian age, with the exception that those rocks exhibit marks which may be lines of bedding, whereas nothing of the kind is apparent here. This may be, perhaps, accounted for by the very steep angle at which it reposes against the syenite, or they may have been obliterated by heat.

The grey rock is not fractured or contorted, it is simply upheaved. Perhaps the question, whether it is of volcanic origin, or an altered stratified deposit, is one which can only be set at rest by the discovery of fossil remains, which, although it would certainly be most satisfactory, is one that we dare not venture to prognosticate. Supposing it to be an altered rock, it may be a Silurian bed, underlying the Caradoc sandstone. At the southern end of the Ercall it assumes a granitoid structure. Reposing partly against this bed, and partly against the syenitic nucleus, we find heaps of grey and white tufaceous sandstone, engirdling the whole chain of hills. Their thickness is best seen along the road to Little Wenlock, immediately after passing the lava quarry in Lawrence's Hill, against which they rest in large quantities. They also form mounds of considerable height on the western side of the Wrekin. On one of these mounds we found a fine plant of *Atropa Bella-*

donna. I know of no more apt comparison for them than the cinder-heaps which we so often see surrounding the smelting furnaces in our neighbourhood. Could we suppose the furnace to be situated in the midst of its own refuse, which it ejected from the top instead of from below, the parallel would be complete. It does, in fact, seem probable that this bed was at some time actually absorbed into the earth's interior by the giving way of a portion of the crust, and afterwards thrown out in showers. There seems no more likely way of accounting for its present appearance and position, for in these tufaceous fragments are found the fossils of the Caradoc sandstone.

If, on entering the Ercall gravel quarry, we turn to the left, and, after pursuing the waggon-road for a short distance, descend the hill, we come to a small brook, marking the line of fault in this place, on one side of which are to be found the grey altered rocks, described above, and on the other, at a much lower level, the unaltered beds of the Caradoc sandstone. These beds lie along the bottom of the valley, in this place scarcely more than a quarter of a mile in width, which divides the Ercall from its opposite neighbour, Maddox's Hill.

Following the course of the brook for a few hundred yards, and then ascending the bank on the opposite side, we come to a small wicket, leading into an arable field. This field is strewn with fragments of the underlying bed, a light-brown, laminated, and micaceous sandstone. Crossing the field, and descending the valley into the road (a thing only to be attempted in exceptionally dry weather, on account of the bogs), we follow that which leads to Little Wenlock, and, after pursuing it to the foot of the Hatch bank, turn to the right, opposite a farm-house, taking the bridle-road through Wenlock Wood. At this place the valley widens considerably. Soon after entering the wood, the road cuts through a bed of pale grey shale, weathering brown, upon which the *Paris quadrifolia* grows. The same bed is visible where the road passes out of the wood. It appears to extend from hence down to the Severn, and also on the south-west of the chain, where it may be seen on the side of the road, leading from Leighton up to Eaton Constantine. At the latter place, further to the west, it is replaced by a compact light grey sandstone, containing *Trinucleus concentricus*, and other lower Silurian fossils. The church at Eaton Constantine is built of this stone. It is crossed by bands of a brown pebbly conglomerate, laden with fragments of fossils. The following list of specimens, found by Mr. Randal, of Madeley, in this bed, along the course of Cound Brook, south of the Severn, is copied from 'Siluria,' ed. 1867, p. 69:—'*Diplograpsus priscus*; *D. foliaceus*; *Orthis calligramma*; *O. testudinaria*; *Disema*; *Lingula attenuata*; *Palœarca elongata*; *Orthonota nasuta*; *Ctenodonta varicosa*; *Theca triangularis*; *Euomphalus, Orthoceras*; *Beyrichia complicata*; *Trinucleus concentricus*.'

The Ordnance Map gives a band of Upper Llandovery (May Hill) sandstone, extending from the Hatch bank, and resting upon the Caradoc shale of Gibbon's coppice (south of Wenlock Wood), gradually thinning out as it approaches the Severn Valley, but I have not succeeded in finding any locality where it is visible on the surface so as to be identified with certainty. Indeed, the difficulty of deciphering the Silurian beds of this neighbourhood is considerable, owing to their position in the bottom of the valley, which is thickly wooded, and the ground well covered throughout most of its extent. It is unwise to trust to fragments picked up at random on the surface, as there are so many different kinds of rock, widely dissimilar in age and character, lying within a short distance of one another, that their *débris* often become mingled by the hand of nature, or that of man. Nevertheless, the succession of beds belonging to the Caradoc series seems tolerably clear as follows:—

(*a.*) Brown, micaceous, laminated sandstone at the base of the Ercall.

(*b.*) Pale grey shale of Wenlock Wood, extending to the south and west of the chain, where it passes into

(*c.*) Compact grey fossiliferous sandstone, and brown conglomerate of Eaton Constantine.

Immediately upon the latter reposes the little coal-field of Dryton.

The above is the succession as it extends to the west. To the east we have the following:—

(*b.*) Wenlock Wood shale.

(*d.*) Upper Llandovery of the survey.

(*e.*) Wenlock shale, extending eastward along the river-bank, on the south of the Hatch bank, until it is overlaid by the Wenlock limestone of Lincoln Hill, a northward prolongation of Wenlock edge.

Standing upon the Southern extremity of the

Hatch bank, where the road from Gibbon's coppice (Spout Lane) joins that to Little Wenlock, it is worth while to pause and feast our eyes on the view presented by the rich succession of Silurian beds on the southern bank of the Severn. In the foreground we have the same Caradoc beds, whose course we have now been tracing, sweeping away to the west in the direction of the mountain from which they derive their name. Immediately above them the upper Llandovery sandstone appears in the ridge of Cressage Park, and Kenley, capped by the Pentamerus limestone. Overlying this is the Wenlock shale, which, being a softer rock, has been extensively denuded, forming a valley between the above-mentioned ridge and that of Wenlock edge, where it is in like manner capped by the Wenlock limestone. Beyond this there occurs another valley, hollowed out of a soft shale, usually classed as Lower Ludlow, but which seems, by the fossils found in it, to bear at least as close a relationship to the underlying Wenlock beds. Then, further to the south-east, there is a band of Aymestry limestone, which passes into the Upper Ludlow rock.

Thus, we have the whole Silurian system laid out before us as in a geological map, unbroken by faults, at least to any extent, or by volcanic disturbance of any kind.

The beds on the north of the Severn can only be considered as a very imperfect representation of these, much disturbed, and wanting in many of the details. The micaceous sandstone, representing the base of the Caradoc series, is considerably faulted and contorted, and, in fact, thins out altogether in the neighbourhood of the Steeraway, where the two ridges of igneous rock approach each other most nearly. The same disturbances which threw up the carboniferous beds to their present position also left their traces in the breaking-up of the underlying Silurian flooring.

CHAPTER IV.

ABSENCE OF THE OLD RED SANDSTONE—BASEMENT BEDS OF THE CARBONIFEROUS SYSTEM — CARBONIFEROUS LIMESTONE—PRODUCTIVE COAL MEASURES—FAULTS AND DISTURBANCES.

It has been observed, in the introductory chapter, that we have, in this part of Shropshire, no representative whatever of the old red system. On the southern border of the Silurian district, that system is extensively developed; but on this, its northern limit, we find the carboniferous beds reposing immediately and unconformably upon a Silurian sea-bottom. The beds about to be described rest conformably upon each other, passing without any break through the three principal divisions of the system.

If, instead of taking the turn to Little Wenlock, we proceed up the hill to the Hatch-kiln, we find the basaltic dyke exposed in a small quarry about half-way up the ascent. This dyke, of later carboniferous age, runs from the Steeraway, above Watling Street, by the Hatch to

Little Wenlock. It is of a coarsely granulated structure, and softer than most basaltic rocks. Lying against it, at the same place, may be seen a bed of carboniferous shale or slate, of a light grey colour, stained with yellow oxide of iron and with purple metallic blotches. This contains numerous concretionary nodules of lime, which have apparently percolated from the superjacent limestone. It dips to the SE. at an angle of 20°. At the southern end of the dyke, where Spout Lane branches off from the Little Wenlock Road, there is a quarry of coarse yellow grit, dipping in the same direction 6°. The adjoining beds cannot be seen in contact with it, but it seems to occupy the lowest position here as the last-mentioned bed does at the Hatch. Neither stratum is, so far as I know, fossiliferous.

These imperfectly developed beds form the true base of the Coalbrookdale field, and represent the lowest or yellow sandstone division of the carboniferous system. In a paper by the Rev. W. S. Symonds, 'On the Transition Beds in Worcestershire and Herefordshire,' there occurs the following passage:—'In the upper strata of the old red of Scotland (the yellow and grey sandstone) many land plants have been discovered, and apparently are allied to those of the coal. It is this upper band in Scotland which is remarkable for the first well-characterised fern (*Cyclopteris hibernicus*), also so marked a feature in the yellow sandstone of Ireland. Calamites also appear in this stratum for the first time, together with fruit-like bodies, believed to be the seed-vessels of some ancient and undefined tree.'* In another paper, by the same author, he refers to two sections in the Forest of Dean:—'Where the yellow sandstone passes *conformably* upwards into the lower limestone shale, and downwards into red marls, sandstones, and the so-called old red conglomerate.' In the same paper, he says:—'In England, Mr. Baxter of Worcester has discovered a *Ptericthys* in these yellow sandstones, below the carboniferous limestone of Farlow, north-west of the Titterstone Clee, in Shropshire, and to which Mr. Roberts, of Kidderminster, has added scales of *Holoptychius* or *Megalichthys*, and a fern as yet undescribed.'

The following succession of beds from Sir Richard Griffiths's carboniferous map of Ireland is quoted by Sir Charles Lyell. It must be read in descending order:—

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* *Edinburgh New Philosophical Journal*, vol. iv. p. 239; *ibid.*, vol. vii., p. 222.

	ft.		ft.
1. Coal measures, upper and lower	1,000	to	22,000
2. Mill-stone grit	350	to	18,000
3. Mountain limestone, upper, middle (or calp) and lower	1,200	to	6,400
4. Carboniferous slate	700	to	1,200
5. Yellow sandstone (of Mayo, &c.) with shales and limestone *	400	to	2,000

We find, therefore, in the succession of strata resting upon the basalt of the Hatch bank, and underlying the carboniferous limestone, the representatives of the upper red sandstone; the yellow sandstone represented by the yellow grit of Spout Lane; the carboniferous slate, represented by the shale of the Hatch.

Having thus satisfactorily proved the correlation of these basement beds, which represent, however imperfectly, the lowest or yellow sandstone division of the system, we now proceed up the bank to the Hatch limekiln, where we find, reposing immediately upon the carboniferous slate, beds of limestone and mill-stone grit, constituting the second division of this coal-field.

Both these may be treated of under the same heading, as the latter is only developed in a few thin bands of coarse sandstone, alternating with

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* *Elements of Geology*, p. 464.

the limestone, and in no respect differing from the bands which continue to be intercalated with the coal-seams throughout the system. This limestone extends in a narrow belt from the Steeraway, above Watling Street, to the end of the Hatch bank above Little Wenlock, being co-extensive with the basaltic dyke.

In many places the beds have been worked out, leaving the intercalated sandstones standing in ridges between the workings, which often extend underground. The mean dip at the Hatch kiln is 24½° SE. They must have been subjected to very great pressure at the period of elevation, for, although specimens of more than one species of *Productus* are frequent, they are almost always in a shattered condition, the fractures having been produced by compression. No other species of *Brachiopoda* are met with, but the limestone is loaded with, and, indeed, in a great measure composed of, corals; many of the specimens figured in Messrs. Milne Edwards's and Jules Haine's monograph on fossil corals having been collected here, though the name of the locality is there wrongly spelt 'Statch.' The following are some of the species most frequently met with:—*Lithostrotion basaltiforme*; *L. irregulare*; *L. Portlocki*; *L.*

Mackoyanum; *L. junceum*; *Lonsdaleia floriforme*; *Syringopora ramulosa.*

The north-western boundary fault of the coal-field runs from the Ercall Wood on the SW. to Lilleshall on the NE., a distance of nearly five miles; and at the latter extremity we find more traces of volcanic action, and the limestone is again brought to the surface.

The hill upon which the monument at Lilleshall stands is composed of a huge mass of lower Silurian rock, traversed by a basaltic dyke. The lines of bedding remain, showing that the rock must have been forced up from below *en masse*; but the structure is highly altered, being semi-crystalline, roasted in some places white, and in others red. Against this mass rests the carboniferous limestone, which here attains a greater thickness than on the SW. and is of two kinds—the lower or white limestone, which is unfossiliferous, and the dark limestone, which reposes upon the former, and is rich in *Brachiopoda* as well as corals. The former are less abundant than in the Steeraway limestone. Of the latter I have collected the following species:—*Productus giganteus*; *Do. var. hemisphericus*; *P. lævis*; *P. striatus*; *P. undatus*; *P. scabriculus*; *Stropho-*

mena analoga; *Discina nitida*; *Lingula mytiloides*; *Spirifera duplicostata.*

The productive measures of the Coalbrookdale field form an anticlinal axis, having its greatest breadth from the Hatch bank to the Cuckoo oak, near Madeley, a distance of about 3¾ miles. It dips to the NW. under the lower Bunter beds of the Tern basin, and to the east under the Permian sandstone. The beds are much contorted and intersected by numerous faults. A vertical section, taken at the Lodge Wood pit, Donnington Wood, on the north-west of the anticlinal, gives 39 yards of shale, &c., before reaching the Fungus coal, as the highest seam is locally termed. Below this occurs the following succession of seams:—

Foot coal,
Stone coal,
Gur coal,
Top coal,
Three-quarter coal,
Double coal,
Yard coal,
Flint coal,
Stinking coal,
Clunch coal,
Two-foot coal,
Best coal,
Randle coal,
Clod coal,

the latter being at a depth of 188 yards from the surface. Many of the upper seams are only from one to two feet in thickness and of poor quality, the most productive being the Top coal, Double coal, Yard coal, Flint coal, Best coal, Randle coal, and Clod coal. Between the seams are beds of different kinds, known to the colliers by various local names; as, Clunch, Blackstone, Bind, &c. The bed which occurs immediately over a seam is termed its roof, as ‘Flint roof,’ and that immediately below is frequently known as the underclay. In the pit in question there occurs what is called a chance measure of Pennystone ironstone, at a depth of 68 yards, above all the coal-seams, and a second bed just above the stinking coal. The above may be taken as an instance of the workings near the north-western boundary.

We now proceed to consider a shaft-section taken further to the east on the downthrow side of what is known as the Great Lightmoor fault, the largest of the many dislocations which affect this coal-field, by which the seams are thrown down 300 feet below the level of those on the western side. Here we find a thickness of 102 yards of ‘espley,’ and other rock, before reaching a thin seam of coal only 4 inches in thickness. Then comes 76 yards of sandstone, shale, and marl (‘clod’ and ‘bind’), before reaching another coal [illegible] inches thick. During the next 128 [illegible] find seven similar seams, all under

1 foot, before the Fungus coal. Below this the seams are nearly the same as on the west of the fault, except that below the Clod coal there are two more measures, the Little flint and the Lancashire ladies, the latter being the lowest seam ever found in this field, and between them the Crawstone ironstone. I am indebted for the sections, from which the above information is derived, to the kindness of Mr. Bradbury, of North Staffordshire.

In the 'Geological Magazine' for October 1866, there appears an announcement of the discovery of coal in the New Stafford pit, near Prior's Lee. The double coal and yard coal were found lying in a perfectly horizontal position, at a depth of 620 feet, which it had taken four years to reach, on account of the hardness of the rock. There were formerly workings near this spot; but the influx of water was so great that they were abandoned as not sufficiently remunerative to pay the cost of working. This may be considered as the eastern point of a horizontal section, taken from Donnington Wood to Prior's Lee, at the northern extremity of the anticlinal.

On the S. after passing over the out crops of thin shaley coal, which lie immediately over the limestone, between the Hatch and Huntingdon, we arrive at the basaltic rock, near the Horse-hay. This is a volcanic outburst of later carboniferous age, by which a considerable portion of the millstone grit (or the sandstone, which is its Salopian equivalent) has been brought to the surface, and may be seen on the sides of the railway cutting of the Wellington, Wenlock and Craven Arms line. The high ground of this neighbourhood forms the apex of the anticlinal arch, the beds being thrown off towards Lawley and Wellington on the one side, and Madeley and Coalbrookdale on the other. Further along the ridge lies the village of Dawley Green. Between these two places runs the Lightmoor fault before mentioned. The older seams of this neighbourhood are, I am told, worked out, and the Springfield and top yard coal are the only ones now in working. Between Finger Lane, which branches off to the left, just below Dawley Green, and Stirchley, another considerable fault is passed, the line of which runs just below the furnaces, and crosses the road in a little valley or depression, exhibiting upon the one side a coal shaft, black and smoky as Tartarus, and upon the other a bank of millstone grit, upon which stand two or three rural cottages with pretty gardens. From Stirchley a moderate walk will bring the geologist to the very interesting sinking of the Madeley Wood Company, through the Permian rock, near Kemberton, described in the next chapter.

If, instead of taking the road to Dawley, the traveller turns to the right at the Horse-hay, he descends into one of the most beautiful and interesting valleys in Shropshire—that of Coalbrookdale. The following extract is from a paper read by the Rev. William Purton, at the meeting of the British Association, at Birmingham, 1865. Speaking of Lincoln Hill, at the lower end of the dale, near the Severn, he says, ‘and there is also exposed a highly interesting section, showing the lower coal-measures resting immediately upon the Wenlock limestone. The lowest seam of coal, the Lancashire ladies and the “Crawstone” ironstone are visible. A walk along the south side of the dale, about a mile, brings us to Lightmoor Wood, in a quarry in which the fossil tree was found which was figured some time since in the “Illustrated London News.” In this quarry we again meet with the Crawstone ironstone, and are able to trace the series of strata upwards to the "little flint" coal and "clod" coal, while in the Lightmoor railway cutting, close at hand, we have exposed no less than six different seams of coal, capped by the "Pennystone" ironstone. In a brick-field, about 100 yards to the north, still higher strata are exposed. And thus, in a walk of little more than a mile we may see in open sections, the whole of the lower coal-measures and a portion of the upper.' I give Mr. Purton's own words, as, never having visited the place, I could only describe it from hearsay.

Having thus described, as well as I am able, two cross sections of the Shropshire anticlinal, we pass on to consider the position and relations of the two other little coal-fields, which are found north of the Severn. They ought, perhaps, rightly to be considered as belonging to South Shropshire, for they have certainly much closer affinities to the coal of Pontesbury and Lebotwood, than to that of Coalbrookdale. On the bank of the Severn, about two miles to the SW. of the Wrekin, lies Eyton rock, the southern extremity of the first Silurian eruptive axis alluded to in the second chapter. It is a mass of greenstone, surrounded by altered Caradoc sandstone; and partly upon this bed, and partly upon the Caradoc of Eaton Constantine, reposes the little coal-field of Dryton, without the intervention of any basement beds. The workings have been closed for many years; and it is principally from the 'Silurian System' (p. 93) that I obtained my information. Sir R. Murchison says, 'The shaft is thirty yards deep, eighteen of which are sunk through overlying detritus of red sand, pebbles, &c. The uppermost of the beds of coal is two feet, the lowest three quarters of a yard thick, separated by clods and sandstone, and there are no traces of the limestone, or of the third bed of coal. The dip is three inches in a yard to the SE.'

The coal-field at Uffington, south of Haughmond Hill, is clearly a prolongation of the Shrewsbury coal-field, just as Haughmond Hill itself is a reappearance of the South Shropshire Cambrian rock. The whole of this field reposes upon the Longmynd grits, and is distinguished, like that of Pontesbury, by an intercalated band of freshwater limestone. The workings at Uffington being closed, I am obliged to refer to the 'Silurian System,' for this shaft section also, which I give in full, because Sir R. Murchison lays great stress upon two points in it, and he is probably the only authority upon the subject either living or in print. These points are: First, the upper beds down to the poundstone, which he considered even then as a proof of the close connection between the carboniferous system and the lower red sandstone, now known as the Permian system. Secondly, the freshwater limestone, which connects this with the Pontesbury field, through its position and fossil remains. These outliers only contain two seams, whereas those of South Shropshire have a third below the limestone. The whole of the South Shropshire district must have suffered much from denudation, and it has probably once extended much further N. Indeed, it is by no means impossible that a connection still exists between the coal of Uffington and Donnington Wood, beneath the overlying Trias, or that coal may be found north of Haughmond Hill, below the Permian sandstone, borings through this rock being generally successful in Shropshire. There seems, in fact, no reason to doubt the continuation of the *lower* carboniferous beds beneath the plain of Cheshire.

Shaft Section of Coal Pits at Uffington.

		Yds.	Ft.	In.
	Drift clay, with boulders or red gravel	14	0	0
Passage from lower new red into coal-measure.	Red clods	5	1	0
	Poundstone	1	0	0
	Red clods	2	0	0
	Grey clods, dark colours above, light below	2	2	0
	Poundstone	1	0	0
	Red curly rock	1	1	6
	Grey clod	2	0	0
	Red rock, with grey partings	2	2	0
	Poundstone, with some red (red marly clay)	1	1	1
	Bassy coal (mush or impure coal)	0	0	6
	Poundstone	1	0	0
	Coal	0	0	6
	Poundstone, both tender and strong	4	0	0
	Hard white and brown rocks (sandstone)	3	0	0
	Clumper beds, Rattlers (concretions), red and white clod	5	2	0
	Mush or impure coal	0	1	0
	Limestone of similar structure, and containing the same organic remains as that of Pontesbury	1	0	0
	Reds	5	0	0
	Blue clods and roof of coal with plants	7	0	0
	Coal	1	0	0
	Poundstone	2	1	0

Beneath this lies a whitish sandstone rock, with brown stripes and other measures overlying the only bed of good coal, which is worked at a depth of 35 yards below the limestone.—*Silurian System*, Ed. 1839, p. 92.

It would, of course, be entirely beyond the scope of this little work to attempt to enumerate even the commonest fossils of the Coalbrookdale anticlinal. All that can be done is to mention a few of the leading genera, with their most usual positions,' and to give references to authorities where fuller information may be obtained. The family of calamites occupies a very prominent position in the sandstone or grit below the coal-measures. Wherever a wall is built of this grit, portions of calamites may be found in every stone. The Paleontographical Society has lately issued the first part of a monograph on the Carboniferous Flora, by Mr. Binney of Manchester, containing the genus *Calamodendron.*

Mr. Binney was, I believe, the first person to point out the connection between the *Stigmariæ* of the underclay and the *Sigillariæ* of the coal-measures, showing that the former, which are usually found upright in their natural position, are the roots of the latter.

The new genus and species of Mr. Carruthers, *Flemingites gracilis,* formerly confounded with *Lepidostrobus variabilis,* is of frequent occurrence in the nodules of ironstone. It is figured and described in the 'Geological Magazine' for 1865.

It is almost impossible to make any selection among the immense variety of ferns found in this field. Perhaps the most common is the *Pecopteris*, which is often found embedded in large slabs in the upper coal roof. *Neuropteris soretii* (Lindley and Hutton) frequently occurs in a similar position, in conjunction with *Sigillaria organum*. We sadly require a new work on carboniferous ferns, and if Mr. Binney accomplishes that, he will, indeed, be a benefactor to geologists.

From the upper coal-measures of Dawley I have received large pear-shaped bodies, apparently the coprolites of some large fish, perhaps the shark. From the same measures, both here and at Prior's Lee, I have procured numerous specimens of *Productus undatus*, and a small *Spirifera*. It will be remembered that the Dawley coal-measures repose probably upon the carboniferous limestone, and, at any rate, they were not far from the marine inlet at the Hatch and Steeraway.

The prevalent conditions of the period must have been thus. At the close of the Silurian age a large portion of the newly-formed beds was raised above the sea-level. Other parts remained submerged beneath the waters of the Old red and Carboniferous seas. These raised beds formed an island, comprehending, I am inclined to believe, the coal-fields of South Staffordshire, Coalbrookdale, and the SW. of Shropshire; and upon this island of Silurian and Cambrian strata the coal-measures were formed, each seam representing the growth and decay of a tropical forest. Afterwards came a second period of elevation, when the Old red sandstone and the lower Carboniferous beds were also raised and became the base of future coal-seams. That a portion of this island was never washed by the above-mentioned seas, is shown by the fact of the coal-measures in the principal fields reposing immediately upon the Silurian and Cambrian beds, while the outliers of Shirlet, and Clee Hill, in S. Shropshire, rest upon the yellow sandstone. There must have been, indeed, a time when this part of the land was gradually raised above the sea-level, forming, perhaps, at first mere reefs of rock, then low swampy islands, in a Carboniferous archipelago; and possibly, at last, attaining to the magnitude of continents, in the same manner, and certainly as gradually, as the British Isles have lately been upheaved from beneath the waters of the Glacial sea.

The later part of the carboniferous era was a period of extensive volcanic disturbance. The basaltic dyke of Maddox's Hill and the Hatch Bank, so often alluded to, against which the basement beds of the whole system rest, must belong to this period, as the beds have evidently been upheaved by it since their deposition. The boundary fault running NE. and SW., from Lilleshall to the Ercall, is apparently a downthrow, caused by the sinking of the beds under the Bunter sandstone. A similar downthrow runs almost parallel to it, through Donnington Wood and Wombridge. Parallel to this again lies the Lightmoor dislocation. There seems to have been a succession of 'settlings,' so to speak, of the newly-formed strata, which must have been at one time of a peaty and muddy nature; and which probably contracted as they hardened, producing parallel lines of fault, or terraces, as we sometimes see them, on a reduced scale, in recent drift-beds. Of course the action of subterranean forces may have had much to do in these cases also. It is hardly probable that the settling down of the coal strata alone could, in all cases, effect such considerable downthrows as we see. The great fire-king was, in those days, 'scotched but not killed.' Like a wounded Titan he lay beneath the weight of the newly-imposed beds, struggling convulsively to regain his former liberty, and leaving ineffaceable marks of his presence, ere he sunk into the state of senile weakness which preceded his decease as far as regards the British Isles.

CHAPTER V.

USE OF THE TERM POIKILITIC—DENUDATION OF THE COAL—CHARACTER OF THE PERMIAN AND TRIASSIC BEDS ON THE EAST OF THE COAL-FIELD—THE SAME ON THE NORTH-WEST.

SIR CHARLES LYELL, in the 'Elements of Geology,' remarks on the convenience of one term which might include the sandstones of both the Permian and the Triassic periods, and suggests for that purpose the adjective Poikilitic.

Although not in general use, its suitability must be recognized when treating of such characteristics as mark these two systems in North Shropshire, where there are exhibited but few of those distinguishing marks which have caused their separation in localities where they are more extensively developed.

Under this head, then, we shall proceed to consider the above-mentioned sandstones, always remembering that the Permian epoch represents the dying out of the old or palæozoic types of organic existence, while the Trias is the commencement of the secondary, or mesozoic age.

We have, in this district, evidence which renders it more than probable that the period immediately following the carboniferous volcanic epoch was one of extensive though unequal denudation. It was stated, near the close of the last chapter, that the coal forests of South Staffordshire and Shropshire grew, in all probability, upon one island of Silurian and Cambrian rock, the higher ground of which was never covered by the waters of the carboniferous sea. Had there been a group of small islets intersected by narrow channels and fiords, we should have had a far more extensive development of marine or lower carboniferous strata. Of course the hills of the Wrekin, and the uplifted Cambrian beds of Haughmond Hill, formed a part of the dry land; but as no characteristic of the types to which the coal vegetation principally belongs is more striking than their selection of low swampy ground for a habitat, it only flourished on the low land, slightly elevated above the sea-level. From its luxuriant nature, however, it is highly improbable that it should not have extended over the whole of that low country, and that it did extend up to the foot of the Wrekin—that is, to the shore of that narrow inlet represented by the basement beds of the Hatch Bank and Steeraway—is shown by the little coal-field of Eaton Constantine and Dryton, resting immediately upon the Caradoc sandstone, without the interposition of any basement beds whatever, in the same manner as the Coalbrookdale beds do at Lincoln Hill. This little coal-field is situated less than three miles from the Hatch Bank, and barely four from the north-eastern limit of the Shrewsbury coal-field; while from that of Pitchford, on the southern side of the Severn, it is about two and a half miles. All these coal-fields rest upon Cambrian or Silurian rocks, without any carboniferous marine strata, the basement beds of the Hatch representing a narrow fiord, or marine inlet. It appears, therefore, highly probable that all the low country was once covered with tropical vegetation, or, in other words, with productive coal-seams.

The question is, and it is a highly interesting one at the present juncture, what has become of these missing seams, which must have occupied an area at least as large as those which remain? Doubtless a large portion of them is buried beneath the Permian sandstone, in the neighbourhood of the coal-fields, faulted down by the giving way of the lower beds, forming inequalities in the surface of the ground which were afterwards filled up by the Permian drift or sandstone. But between the Hatch and Eaton Constantine we have no such covering, but simply an exposed surface of Caradoc sandstone. Between the coal SE. of Haughmond Hill and the workings at Donnington Wood is a distance of about nine miles, throughout which the country is overlaid by a thick covering of lower Bunter sandstone, filling up what must once have been a deep valley between the two fields. In all probability these separate workings once formed parts of the same field, and the removal of so large a portion of the productive coal-seams could only have been effected by some very powerful and unequal denuding agent, such as ice, moving over the surface. Professor Ramsay's theory of a Permian period of glaciation seems the most natural and simple explanation. It also explains the break in the chain of being, for the change, however gradual, from a tropical to an arctic climate, would certainly annihilate most of the living organisms which flourished under the former.

The result of the period of volcanic activity at the close of the carboniferous era was to throw the whole country into a system of flexures, and in this neighbourhood to upheave the Coalbrookdale and South Staffordshire coal-fields, leaving a deep valley, or synclinal trough between the two, in which the same coal-seams which are brought to the surface by the Shropshire anticlinal probably lie concealed under the superjacent Permian and Triassic sandstones, which on the Shropshire and Staffordshire border on what would be the lowest part of the concealed synclinal trough, attain a very considerable thickness. I do not know what evidence is to be found in Staffordshire of the existence of this trough, further than the reappearance of the Permian beds, but in Shropshire it is very strong.

The Permian sandstone (*roth-liegende*) of Shropshire is a coarse-grained purplish-red stone, without fossils. It overlies the coal in the high ground of Lilleshall Hall and woods on the NE. It is faulted down to the level of the carboniferous beds S. of the New Lodge Farm, and this fault continues running due S. by Prior's Lee (near which place it may be seen in the cutting of the Great Western Railway, where the Permian sandstone lies against the upper carboniferous beds), below the Hem coppice, near Kemberton, and on to the Cuckoo oak, forming the eastern boundary of the visible coal-seams. North of the Hem coppice there occurs another fault, running in a south-easterly direction, at an acute angle to the boundary fault, and known locally as the Great Symon fault. This seems to be the real termination of the workable coal-measures in this direction, as, if they exist on the down-throw side, it is at such a depth, and covered by such a thickness of Triassic deposits, that it would be impossible to reach them in the present state of science. A shaft has been lately sunk by the Madeley Wood Company, close to the Hem coppice, on the S. of this fault, to a depth of 360 odd yards. After boring through about sixty yards of red 'espley' (Permian sandstone) they found the following seams:—

Top-yard coal.
Big flint.
Double coal.
Clod coal.
Little prince.
Lancashire ladies.

These seams have been followed for a considerable distance to the E., under the Permian rock.

Another line of fault about a mile to the E., running by Decker Hill, Haughton, and the Hem house, brings the lower Bunter sandstone down to the level of the Permian beds. The former is a soft, bright red stone, which has suffered much from the effects of denudation, and does not often appear upon the surface. The town of Shifnal is built upon it, and it runs from thence round the base of the Manor Mount, by Evelith, to the Forge, which is in its furthest limit on the E. It is overlaid by the Triassic conglomerate, the outline of which is well marked, as it forms all the high ground of the neighbourhood, running from the Lizard Hill, through Upton, Brimstree Hill, and the Manor Mount on the W., and is faulted down and disappears at the latter place, but continues from the former through Hatton Dingle on the E., where it is crossed by another fault, extending from thence to the Forge Bridge, and marked by a small brook, which at the latter place flows along the line of dislocation, and has hollowed out a beautiful little ravine, on the other side of which the Triassic conglomerate again appears at Grindle, and forms the high ground to the west of Ryton. Thus it will be seen that it occupies a position of considerable importance in the geology of the neighbourhood. It is of a somewhat coarser grain than the preceding bed, and contains more or less numerous pebbles of quartz—pink, white, and yellow—which strengthen its substance, and enable it to resist the influence of time and weather. Mr. E. Hull considers these pebbles to be derived from the denudation of the old red conglomerate of Scotland, washed southwards, or, in his own words—'The new red conglomerate of England was the daughter of the old red conglomerate of Scotland.'*

Immediately overlying this is the sandstone, marked as f. 3 in the map of Geological Survey; but I confess that I am at present unable to distinguish any difference between this and the red base of the waterstones, as seen at Beckbury, Albrighton, and other places in this neighbourhood; more especially as it is overlaid by several detached patches of red and grey Keüper marl. One of these outliers has existed at the back of Hatton Grange, where there are several marl-pits, now worked out and filled with water. Another is visible on the right-hand side of the road by Cosford Grange, going to Wolverhampton; and I cannot perceive any difference between the red Keüper sandstone underlying this and the sandstone at Aitchley and other places beyond the eastern limit of the conglomerate. Much of the country beyond Cosford is overlaid by these marls, but there is a good section of the red waterstones below the village of Albrighton, close to the Staffordshire border.

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* *Geological Magazine*, April 1869, p. 183.

Having thus traced the succession of Poikilitic beds on the E., it remains to consider those on the NW. of the carboniferous anticlinal.

The downthrow of the boundary fault on this side is much greater, and the Permian beds do not appear at all in immediate conjunction with the coal, though a little patch which comes to the surface at Preston on the Weald moors would seem to indicate a thin spot in the system, suitable for future experiments. It reappears on the flanks of Haughmond Hill on the SW. The Triassic beds on this side form an almost continuous series, running from the Wrekin chain on the SE. to Grinshill, and Hawkstone on the NW., beyond which they dip under the Lias, on the Cheshire border.

This extensive area, embracing by far the larger portion of North Shropshire, forms a plain or shallow basin, varied only by those erupted masses which have been previously described. It is now drained by the little river Tern, which, taking its rise in the Lias, flows idly through the whole succession of beds, until it falls into the Severn, near Attingham, between Haughmond Hill and the Wrekin.

The whole of the valley between these two ridges is covered by the lower Bunter sandstone (f. 1 of the Geological Survey), above which the Triassic conglomerate is found in detached outliers, as at Bigwood quarry, near Longdon upon Tern, and in the neighbourhood of Tibberton. It has probably once occupied a much more important position, for pebbles from this stratum form a large proportion of the low level drifts of the Tern.

On the N. and W. of Haughmond Hill these beds are overlaid by others (f. 3) very similar in appearance, but occurring above the conglomerate and immediately below the waterstones. They are found at the base of Pimhill and Grinshill, but are concealed by drift throughout most of their extent. Above these beds lie the red base of the waterstones, as seen at Harmer Hill, Pimhill, Grinshill and Hawkstone. At the Clive these red sandstones may be seen passing upwards without any break, not even a line of bedding, into the white building stone (f. 5 of the Survey). I have before adverted to the extreme difficulty of drawing a line between the upper Bunter (Broomesberrow beds of Worcestershire) and the waterstones, which is increased by the fact that we have here no *lower* Keüper marls. In the above division I have followed the Geological Survey.

That portion of the white sandstone which forms the escarpment of the Clive is loaded with minute concretions of sulphate of barytes, like small marbles, which are continually falling out of the matrix, leaving it in a honeycombed condition, and consequently quite useless for economical purposes. Thousands of these little round substances may be seen scattered over this part of the hill. A vein of copper ore runs through this bed, and was formerly worked, but is now exhausted.

Passing onward to the Grinshill quarries, we find the white sandstone increasing in thickness and developing into a beautifully compact, fine-grained building stone. This is overlaid by a bed of flag-stones composed of a pure white, arenaceous silt, occasionally coated with what appears to be a serpentinous and alkaline mud, baked and glazed by the sun.

It is in this silt and mud that we find the clearest indications of littoral conditions. The surfaces of the flags are frequently covered with the ripple marks left by the receding waves, sharp and well defined, as though they had retired but a few hours ago. There are also the holes left by the rain-drops as they fell into the soft sand, and the indentations caused by tide-pools, with their muddy coverings cracked by the sun's heat at low tide. Most striking of all, there are the footmarks of that curious animal, the *Rhyncosaurus*, as he slowly paced the beach in the intervals between the tides. The fossil remains of this creature are occasionally found in these quarries. A fine specimen of its head was for some time in the possession of a person whose husband had been connected with the quarries, and who declined to part with it on any terms. She left the neighbourhood, and the fossil was for a time lost sight of, but it was inherited at her death by her daughter, who generously presented it to the Shrewsbury museum. Other portions of the skeleton have been found.

The flagstones are divided from the underlying sandstone by a line of rubble. They are overlaid by the red Keüper marl, with occasional included *débris*, consisting of angular fragments of sandstone, which is called provincially 'Fea.' The colouring matter seems to be the same form of oxidised iron as that which imparts its red tint to the boulder clay, and it is soluble in water in the same manner, for, wherever the rain or surface springs have penetrated downwards through the red marl into the porous sandstone, the latter has received a pink tinge. The marl, as has been before remarked, is again overlaid by the lower Lias and marlstone.

The Triassic period represents the submergence of what were once the islands and forests of the carboniferous epoch. Whether this took place to any great depth beyond what we now see it is not easy to ascertain. Certainly the range of altitude of the beds of this age against the higher mountain sides is not very lofty, but from their soft and porous structure they are peculiarly liable to the action of later denuding agents, and have probably attained in many localities a far greater thickness than they now exhibit.

The sea-beaches of the Keüper age seem to indicate a period of emergence similar to that which took place when the land rose from beneath the waters of the glacial sea. We learn that the attraction of the moon exercised the same influence upon the ebb and flow of the tides as now. And as these do not occur in small or land-locked pieces of water, we also perceive (what, indeed, is self evident) that the Triassic sea was a wide-spread ocean, whose flux and reflux, encroachment and retrogression, were substantially the same, regulated by the same laws as those of the broad Atlantic are now, and which, for anything we know to the contrary, have existed since the beginning of time. Professor Harkness arrives at the same general conclusions, by a review of the same phenomena exhibited in the Triassic beds of the northern counties. He thus concludes his paper on the 'Records of a Triassic Sea-shore:'* —'On these ancient shores we find proofs of physical conditions of a very perfect character, and evidence of like conditions may be met with on our present shores, resulting from the same causes, where we have the concurrence of such circumstances as favour the production and preservation of the phenomena which emanate from these conditions.'

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* *Edinburgh New Philosophical Journal*, vol. vii.

CHAPTER VI.

INTERVAL OF TIME BETWEEN THE SECONDARY AND QUATERNARY DEPOSITS—GLACIAL DRIFT OF STRETHILL—MARINE DRIFTS ON THE EAST OF THE PLAIN OF NORTH SHROPSHIRE—THE SAME ON THE WEST.

We have seen that the monolithic inscriptions which we have been endeavouring to decipher do not contain by any means a continuous record. On the contrary, we cannot trace the history of a single period without finding some missing links, some intervals which must be filled up with evidence gathered from other localities, just as in gathering the early history of mankind from the sculptured monuments which are found in the neighbourhood of his birthplace, we are often obliged to turn to other sources to fill up the blanks in the series.

Geology has often been compared to a written book; but it rather consists of a number of contemporaneous records, each of which, while it traces the particular series of events relating to the locality of which it treats, fails to notice those which occurred in other places at or near the same time; and it is by the correlation of these numerous records that we arrive at general conclusions regarding the history of the whole globe.

We now find a longer blank space in our Salo pian stone record than we have yet met with, in the absence of the whole of the deposits of the tertiary period. Oolitic forests never grew in Shropshire; her hills were never washed by the cretaceous sea. The forest and fluvio-marine beds which bear testimony to the mild warmth of the Pliocene climate in the east of England, where they underlie the boulder clay of the glacial epoch, have no representatives in the west. The boundaries of this gulf of time consist, on the further side, of the inferior Lias; on the nearer, of the later Boulder clay.

The drifts of the Severn Valley have already been treated of by an abler pen than mine. I will only allude to the section at Strethill, Coalbrookdale, because it affords, I believe, the only instance of true boulder clay occurring in this part of Shropshire. I give the section in Mr. G. Maw's words:—'*Strethill, near Ironbridge, Severn Valley.*—From 100 to 310 feet above sea; 210 feet thick. A stratified hill of drift, consisting of 70 feet of sand and gravel at its base, 70 feet of boulder clay, and capped by a further bed of sand and gravel 70 feet thick.'*

The larger part by far of the drift beds, which are so widely spread over the plain of West Shropshire, are of a marine or estuarine character.

To use the words of another Shropshire geologist (Rev. W. Purton):—'There was, beyond doubt, a period when the waters of the glacial sea covered the low lands of Cheshire, Flint, Denbigh, and North Shropshire; while such elevations as Wenlock Edge, the Longmynd, Caradoc, and Wrekin, Cyrn-y-Brain, and Eglwyseg rocks were above water, as well as the higher peaks.'†

It is this period which has left such unmistakeable marks over the country which we are now treating of, removing large portions of the softer beds, causing irregularities and depressions in the surface, smoothing and rounding the general outline of the country, and finally depositing the most unmistakeable proof of all in the banks of drift, loaded with the remains of marine shells, which have accumulated wherever the sea level remained the same for a period long enough to form a coast line.

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* *Quart. Journ. Geol. Soc.* 1864.

† *Geol. Mag.* June 1867.

I propose first to consider these drifts as they are found on what was once the eastern shore of the North Shropshire sea, together with those gravels which, though found at a lower level, may be supposed to have been in a great measure derived from them; and then, crossing to the western coast, to observe the same succession as it appears nearer to the Welsh border.

In the chapter which treats of the carboniferous period, I remarked upon the boundary line of fault extending from the Ercall to Lilleshall Hill, a distance of about four miles, occasioned probably by the giving way of the softer strata under the Bunter sandstone. This fault afforded a weak place for the sea to work upon; and it is along this line that we find the most decided marks of its presence. First, it appears to have effected a large amount of denudation, for we find fragments of the denuded beds scattered throughout the valley; secondly, it has deposited a terrace of clay and shingle, extending through Lilleshall, Ketley, Hadley, the higher part of Wellington, below Haygate and Orleton, containing marine shells throughout its whole length. These beds were first noticed by Sir Roderick Murchison, in 'The Silurian System,' where he describes them as 'northern drift,' and particularly refers to those deposits containing marine shells, which occur on the north-western slopes of the Wrekin. Since that date the labours of Mr. Maw and Mr. C. J. Woodward, and others, have shown us, by means of the organic remains contained in it, that this, our oldest drift, is not altogether of a decidedly glacial character, but that it contains several Arctic species, mingled with a larger proportion of recent shells, chiefly of the boreal type; and belonged probably to that milder period which interposed between the deposition of the early boulder clay and the second glacial epoch, when the surface of the country was furrowed by melting snows and land ice. Floating glaciers from the north must have been frequent, with their loads of disintegrated material; and these, becoming stranded on the higher ground, would melt and disappear, leaving the drift matter behind them. It is principally to this epoch that the denudation of the Triassic conglomerate on the NW. of the carboniferous anticlinal must be attributed. It probably once occupied as important a place here as on the south-eastern border, and its round quartz pebbles are found in great abundance in every drift bed in this locality.

In a paper read before the British Association, at Birmingham, 1865, Mr. C. J. Woodward describes that portion of the drift which is exposed in Fox Hill field, New Lodge farm, Lilleshall. He says—'Fox Hill field is a mound about 30 feet high, sloping equally on all sides. The whole of the mound is composed of moderately fine gravel, and on the north side are beds containing comminuted sea-shells, with a few specimens nearly entire. Lias fossils, much water-worn, granite pebbles, and sub-angular fragments of sandstone, curiously pitted on their surface, occur with the shells.' Mr. Woodward then proceeds to enumerate no fewer than 22 species of glacial and recent marine shells which have been found in this locality. At the end of the paper, he states the top of the mound to be 463 feet above mean sea level.

This bed lies to the E. of the line of fault and upon the Permian sandstone, which, in this place, overlies the coal, not being faulted down as it generally is. At the time of the deposition of the drift it must have formed an island, separated by a very narrow strait from the adjoining anticlinal.

It contains a large proportion of sand, in which comminuted shells occur in great abundance, but perfect specimens are very rare. I was able to identify some six or seven of Mr. Woodward's list of species, *Turritella communis* being here, as elsewhere, the most frequent.

In digging the foundation of Hadley Church, in 1854, a bed of marine drift was cut into, lying upon the lower Bunter sandstone, on the downthrow side of the boundary fault, containing specimens of *Turritella communis*, and *Tellina solidula.*

The road from Oakengates, through Ketley and Watling Street, runs over a thick deposit of marine drift. It is particularly observable against the terrace formed by the fault between Oakengates Church and Ketley on the upper side, and Wombridge on the downthrow side; and again at Ketley Brook, where we find the shingly sand, with the usual materials, resting upon brick clay. This is a good section, lying exactly upon a line of fault, and well exposed.

From this point the faults cease to exercise any influence in the direction of the drifts. We find them reappearing in the Haygate Road, S. of the town of Wellington, upon the Bunter sandstone. On the left-hand side of the road, approaching Haygate, they form a bank of clay, containing a few shingles of granite and other transported rocks, and angular fragments from the Wrekin and Ercall. On the right of the road, lying against the clay, at the same level, is a bed of sand and gravel, containing numerous fragments of shells, among which nearly perfect specimens may be sometimes met with, even retaining their colour. This bed reappears at the back of Orleton, against the Greenstone dyke of Wrockwardine Hill. Its proper position, here as elsewhere, along the line of drift, is evidently above the clay. It will be observed that everywhere along this line the sand and gravel contain abundance of comminuted shells, while the clay is entirely destitute of them. Nevertheless, the absence of boulders or ice-marked fragments, as well as its position, render it more than doubtful whether the latter can be considered a true boulder clay.

Thus, we have spread out, and for the most part unconcealed by any talus of later date, an old sea coast of full 5½ miles in length, with its sand, its shingle, and its drifted shells, just as it may be seen on most recent sea-margins. It represents a period when, the higher ground having risen above the waters of the glacial ocean, the Severn Valley still formed part of a sea, extending from Bristol, through the ancient straits of Malvern and Shropshire, into Staffordshire and Lancashire; and of this sea the North Shropshire basin formed an important part.

Looking over the plain, we can still distinguish its outlines, such as it was at the time when the Wrekin and the adjoining hills formed a promontory, washed by the Severn sea on the SE., and by the North Shropshire, or, as I have elsewhere called it, the Tern basin on the W.; when the Haughmond and Wrockwardine ridges existed as reefs of rock, and when the upraised Keüper beds of Grinshill and Hawkestone were a flat sea coast, which could be dimly discerned from the higher ground on the opposite side.

Speaking of the causes which have produced the general outline of the country, Professor Ramsay says, in his address to Section K of the British Association, 1866—'The mountainous character of the country, as it now presents itself, is due, not to direct volcanic action, but to the unequal hardness of igneous and aqueous masses, acted upon by many denudations both ancient and modern, both marine and subaërial. These causes, aided by faults, which often brought hard and soft rocks into immediate juxtaposition, have given rise to all the rugged outlines on the surface of Wales; the hard rocks more strongly resisting decay and waste, the soft ones yielding to time, decay, and weather, with greater ease; and thus it happens that the harder masses generally form headlands and the summits of mountains, though often found elsewhere; while the softer strata, wasted away by the sea, and by rain and rivers, are apt to lie in the recesses of bays and valleys.' These remarks apply with great propriety to the country on both sides of the Severn.

Between 200 and 300 feet below these beds, in the lowest part of the valley, we find others which, from the similarity of the materials, bear a striking affinity to them. These are the low level drifts of the River Tern. This little stream has been previously described, winding its way slowly along through the flat pasture lands, which it enriches every winter by its overflow. But that it was once a more powerful stream, is shown by the banks of shingle, which here and there rise to a height of from 10 to 20, or 25 feet along its sides.

A bed of this gravel was opened at Crudgington, in 1866, by the Wellington and Market Drayton Railway Company. It contains all the materials of the older drift: viz. red sandstone, chiefly Permian, quartz pebbles from the Triassic conglomerate, carboniferous limestone, granite, both pink and grey, and fragments of igneous rocks. To these are added a large number of flints, much chipped and rolled, and occasionally rolled pieces of lignite. The deposit at Crudgington consists of three beds, as follows:—

	Ft.	In.
Fine gravel mixed with red sand, about . .	2	0
Yellow sand with less gravel . . .	2	6
Red clay, sand, and gravel . .	(Unknown.)	

The bed lies about 100 yards from the bank of the River Tern. It is now much disturbed, having been used as material for the railroad.

The same gravel appears again at Walcot, where it attains a considerable thickness, on the sides of the road going down to the mill. Here, however, the two upper beds are absent, the whole deposit consisting of gravel and red clay.

The age of this drift must be considerable, for the Tern is a small, slow river, with little power of transporting materials or re-making its banks. Possibly it may once have formed part of a much older formation, nd the clay and shingle beds may be nothing else than a re-arranged boulder clay. The process is one which may be seen in any part of the coast where that bed extends down to the sea level. First, the clay and lighter material are washed down, forming a bank at or below low-tide mark. Then, the heavier materials, which have been left higher up the beach, follow, partly by their own weight, and are rounded and crushed in the process. With them mingle the sand and up-washings of the tide, so that the lighter material is found lowest, as it is in these drift beds.

We find the marine drifts much more widely spread, and partaking of a more decidedly glacial character, on the western side of the plain. The following section, exhibiting a succession of beds, is taken from the high ground of Merrington Green, in the neighbourhood of Pimhill, down to the level of the river Perry :—

(*a.*) Coarse, unstratified sand and shingle, with fragments of shells, capping Merrington Green.

(*b.*) Brick clay of the Old Woods and Leaton, immediately underlaid by

(*c.*) Stiff blue clay, containing carbonate of lime.

(*d.*) Finer stratified gravel and sand, extending down to the river-bed.

The fragments of shells in the upper bed are so completely comminuted that it is impossible to identify them. The same bed is visible in the ballast-hole, by the side of the Shrewsbury and Chester Railway, beyond Baschurch station, a distance of 3½ miles, at a much lower level.

The bed of clay (*b.*) used for brick-making has a lateral extension of about 2¾ miles from Fennymere to Leaton, where it is again capped by gravel, which, however, bears a much stronger resemblance to the type (*d.*) than to (*a.*). From this bed I obtained a very perfect specimen of *Fusus antiquus*. The blue clay (*c.*), which appears to be the oldest bed underlying all the others, was sunk into in boring a deep well at the Hayes farm, and was found to be loaded with crystals of carbonate of lime. It is also visible at the brick-yard near Leaton. From its colour it may have been derived from the denudation of the Lias. The stratified gravel (*d.*) has a very wide extent, lying in mounds above the clay, upon much of the low ground, and filling many of the hollows in the neighbourhood. It has evidently nothing whatever to do with the actual stream and river system, for it is often spread over flat ground or upon hill sides where there is no stream near;

nor, from the nature of the ground, could there ever have been one, and is sometimes cut into by small streams, as is the case with the Walbrook, between Yeaton and Walford, and along the Perry, from Yeaton to Milford. It does not contain shells. Several distinguished geologists have laid great stress upon the action of land-ice and melting snows, after the land had risen from beneath the ocean. The Rev. O. Fisher describes a deposit in the Thames Valley, which he calls the trail, and which he supposes to have been formed by the action of land ice, ploughing it into furrows on the surface. The gravel, above described, may have had a somewhat similar origin.

From the varying levels at which the beds are found, it would appear that they have rather followed the outline of a previously formed contour than originated any great change. The general configuration of this part of the country must, therefore, date from or even before the early glacial epoch, when it may have lain bound beneath a sheet of ice, and afterwards have been furrowed by streams flowing from the melting glaciers of Wales.

The following catalogue of shells, found in the Shropshire drifts, is compiled partly from Mr. G.

Maw's paper in the 'Quarterly Journal of the Geological Society,' partly from that of Mr. C. J. Woodward on the Lilleshall drift, and from other sources. It contains all the species at present known, but much remains to be done in this way; and it is greatly to be wished that both field clubs and private collectors would bestir themselves vigorously to discover new localities and new species, and thus add to our knowledge of this highly interesting and, until lately, little known subject. All the species from Strethill are given on the authority of Mr. G. Maw, and by his kind permission.

CATALOGUE OF SHELLS FOUND IN THE NORTH SHROPSHIRE MARINE DRIFTS.

Univalves.

Aporrhais pes-pelicani, Strethill, Lilleshall.
Buccinum undatum, Strethill, Lilleshall.
Defrancia turricula, Strethill.
Dentalium abyssorum, Lilleshall.
D. entale, Strethill.
Fusus antiquus, Strethill, Lilleshall, Old Woods Clay Pit, between Baschurch and Leaton, Haygate Road.
Littorina litorea, Strethill.
L. rudis, Strethill.
Murex erinaceus, Strethill.

Nassa reticulata, Strethill, Lilleshall, Haygate Road, near Welsh Bridge.

Natica clausa, Lilleshall.

Purpura lapillus, Strethill, Lilleshall Road, near Welsh Bridge.

Scalaria communis, Lilleshall.

Turritella terebra (Syn.), Strethill.

T. communis, Lilleshall, Hadley, Haygate Road, near Wellington, Orleton, Welsh Bridge, Shrewsbury.

Trophon Bannferius, Lilleshall.

Trochus magus, Strethill.

T. umbilicatus, Strethill.

T. cinerarius, Strethill.

Bivalves.

Astarte borealis, Lilleshall, Strethill, Welsh Bridge, Haygate Road.

A. compressa, Welsh Bridge, Haygate Road.

Anomia ephippium, Strethill.

Cardium echinatum, Lilleshall, Strethill, Welsh Bridge, Merrington Green, between Baschurch and Leaton, Haygate Road, Wellington.

C. edule, Strethill, Lilleshall, Welsh Bridge, Haygate Road.

Cyprina Islandica, Strethill, Lilleshall, Welsh Bridge, Haygate Road.

Lutraria elliptica, Lilleshall.

Mactra solida, Strethill, Lilleshall.

M. subtruncata, Haygate Road, near Wellington.

Mytillus edulis, Strethill, Lilleshall.

M. modiolus, Strethill.
Ostrea edulis, Strethill, Welsh Bridge.
Pecten opercularis, Strethill, Lilleshall.
Pholas crispata, Strethill, Lilleshall.
Psammodia Feroensis, Strethill, Lilleshall.
Saxicava rugosa (*var. Arctica*), Strethill.
Tellina Balthica (*var. solidula*), Lilleshall, Strethill, Hadley, Welsh Bridge.
T. calcarea, Strethill.
Teredo Norvegica, Strethill.
Venus Striatula, Welsh Bridge, Haygate Road.
Venus exoleta, Strethill.
V. tincta (Syn.), Strethill.
V. lincta Artemis, Haygate Road.

Cirripedes.

Balanus balanoides, Lilleshall, Strethill.
B. Hameri, Strethill.
B. porcatus, Strethill.
B. sulcatus, Strethill.

Annelid.

Pomatoceros triquetra, on *Ostrea edulis*, Strethill.

Sponge.

Cliona celata in *Fusus antiquus*, Strethill.

CHAPTER VII.

LAKE PERIOD—FOREST PERIOD—REMARKS UPON ATMOSPHERIC DENUDATION.

After the land had risen from under the sea, there was a time when the level of the latter stood from twenty to fifty feet higher than at present, and when many of the depressions on its surface were in consequence below the sea-level. The effect of this upon the system of drainage will be at once apparent. As there was less fall, the flow of water towards the sea would be more gradual. The rivers, while probably of greater width, would be far less rapid and powerful; liable to pound back at a very slight obstacle, instead of forcing their way through it or round it, causing frequent inundations; while the depressions above alluded to, having no fall, must have remained undrained. At the same time, there must have been spread over the surface of the land a far greater volume of water than at present. The result of this state of things was that an extensive lake system, of which we find many decided traces, spread itself over a great part of the country, and particularly over the western counties.

Speaking of this period, the Rev. W. S. Symonds says—'There was a time, long antecedent to the days of the Romans, when both the Severn and the Avon flowed, as the river Shannon does now, through a chain of various sized lakes. The race-courses of Worcester, Upton-on-Severn, Tewkesbury, and Gloucester, were formerly lakes forty and fifty feet in depth, into which the ancient Severn poured sediment for ages, until the beds of the lakes became gradually silted up, and the river, cutting a channel through the lacustrine silt, from time to time, altered its course, and deposited river alluvium above the lacustrine mud.' * The higher part of the town of Shrewsbury must have once formed an island in one of these lakes. The same truth which applies to the Severn is also apparent of many other rivers, such as its twin stream, the Dee, which must have flowed through the old lake-basin of the Roodee at Chester. The river Tern, too, must have been the outlet

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* *Geology of the Railway between Worcester and Hereford.*

of the large Wealdmoor lake, the basin of which lies in the lowest part of the North Shropshire plain. This basin, about seven miles in length by four in breadth, is entirely hollowed out of the lower Bunter sandstone (f. 1.), the margin being formed in a great measure of detached outliers of Triassic conglomerate. The lowest bed that has been reached by deep draining is the sand, which has been previously alluded to as a marine deposit, spread over all the eastern part of the plain. Immediately above this is a thin layer of blue clay, containing rootlets, representing the old lake bottom. This is overlaid by about six feet of peat, containing branches of oak and hazel, the former frequently blackened, as in the case of the Irish mosses; and the latter in a pulpy condition, matted together by layers of rootlets, and also by a species of coarse-fibred moss too decayed to admit of identification.

The blue clay is overlaid at Long Lane, in the neighbourhood of the river, by a considerable depth of red clay mixed with shingle, and both beds are extensively worked for brick and tile making. I found a fragment of *Unio* in the latter bed, in the Duke of Sutherland's brick-yard at Long Lane. This lake must have been formed by the pounding back of the waters of the Tern into a depression already existing. Probably, many other streams, pouring down from all parts of the surrounding higher ground, found an outlet into it, being, in fact, the receptacle for most of the drainage of the whole plain.

That the Weald Moors existed, partially at least, as dry land, in the time of the Romans, is evident from the remains of the Roman encampment at the Wall, near Tibberton, though the ground here, being near the edge of the depression, is somewhat elevated, and was probably drained before the rest. Some bronze celts, of artistic workmanship, were found in draining near Preston. They are now in the possession of Mr. Cooper of that place. Many names of localities, derived from the Saxon, attest the condition of the country at the time they were given, as Eyton, from eah or eye, an island; Kinnersley, from Kinnaird's eye. The name Weald is derived from the Anglo-Saxon; German, wald, a forest.

In the neighbourhood of Ellesmere the lake system was much more developed, and, in fact, still remains; the lake of Ellesmere and its smaller neighbours being, probably, relics of the period.

In one of the peat-mosses in this neighbourhood an interesting indication of man's existence at this distant epoch was discovered. In cutting a deep drain on Whettal Moss, the property of Earl Brownlow, in 1866, a canoe was found buried in the peat, six feet below the surface, and under the roots of a large birch-tree. It was hollowed out of the trunk of a single oak, and is 11 ft. long, 2 ft. 5 in. wide, and 1 ft. 4 in. deep. It is now in the possession of Captain Cust of Ellesmere.

The human being of the lake epoch was a far more civilised individual than his predecessor of the low level drifts. He belonged either to the neolithic or later stone, or else to the bronze age. As we learn from that most interesting volume, 'Keller's Lake Dwellings,' there was a race in Switzerland antecedent to the Romans (and the early period of the Swiss lakes at which this race existed, must have been nearly cotemporary with our drained lake beds), who built their dwellings upon piles driven into the mud, used artistically made bronze and stone tools and weapons, wove cloth out of hemp and flax, manufactured pottery, kept domestic cattle and dogs of a large size, caught their fish in nets, and, in fact, lived with many of the comforts and appliances of civilised life. Of course the progress of civilisation varies, and lacustrine man of the British Isles may not have reached the same point as his Swiss brother; at any rate, he has not left us so many traces of it. We know of no remains of any habitations of this period, but that he was a manufacturer of pottery and of bronze we do know; and it is, therefore, probable that he was acquainted with some of the other arts which constitute the comfort and refinement of civilised life.

Cotemporary with the later part of the lake period and outlasting it there must have been an epoch when the country was covered with forest trees, growing at first only upon the higher ground, but extending themselves gradually over the surface as it became drained. The choking up of some of the smaller lakes seems to have been caused by the trees on their banks falling into them as they decayed. But their general disappearance was occasioned by the gradual elevation of the land, until it stood considerably higher than it does now. Then the forests took possession of the forsaken territory, and the fairies of the wood disported themselves under the spreading oak tree, quaffing dew from the acorn-cups, by the light of the glowworm's lamp, in spots that erst were sacred to the graceful Undine and her sister Naiades. In prosaic fact, then did man, no longer the simple dweller in wooden cabins, build for himself habitations of stone, some of which, now submerged beneath the waves of the Irish Sea, were then shaded by the green branches of forest trees, among which the red deer and the roe roamed at will, but whose present inhabitants are—

> The scaly tribes which sweep
> The bosom of the boundless deep.

Proofs of these facts are found in the submerged forest bed, which appears at intervals on the Welsh coast, between Rhyl and Penmon Mawr, and in traces of stone habitations visible at low tide below Abergele and Rhos yn Llandrillo. These are brought forward here for the purpose of showing how much the level of the land in the west of England has sunk since their existence.

This bed was probably an extension of the great Snowdonian forest, the remains of which are found in most of the peat bogs which occupy so much of the low country in North Wales. We are enabled to correlate it with the Wrekin forest by means of the vegetable remains, among which the oak and hazel largely preponderate, showing that both forests grew under the same climate and conditions. They may be also related in point of time to the latest forest period of Scandinavia, as recorded in the peat bogs of Denmark, corresponding to the close of the bronze and commencement of the iron age of human history.

Besides the above-mentioned animals and the present denizens of our woods, the Fauna of the forest period probably included the wild ox (*Bos primigenius*) and the Irish elk (*Megacervus Hibernicus*). The portions of the antlers of the latter, found among the remains of the bone manufactory at Uriconium, are, indeed, no proof of his existence at the date of that city, since they may have been brought there in a fossil state; but they argue strongly for the prevalence of the remains in England, for the Romans had little or no communication with Ireland, and would not have been likely to take the trouble of transporting such unwieldy objects for the purpose of manufacture. We now come to what seems to have been the latest change in the relative levels of the sea and land, a change which, according to all appearances, is still in progress, at least on the western coast. This is the commencement of a very gradual submergence of the land, causing, of course, a rise in the sea level. We have no means of arriving at any certainty with regard to the time which may have elapsed since this change commenced. Tradition whispers vaguely of a date when the island of Priestholme or Puffin Island was united to the mainland, and when the Menai Straits might be crossed on foot. A surer guide is found in the changes traceable to this cause, which have taken place in the interior of the land. The principal one is the destruction of the forests in the lower ground and the formation of peat bogs. As the fall in the drainage diminished, the force of streams and rivers diminished in proportion. Only a certain amount of water found its way to the sea, and the rest, soaking into the earth, sapped the roots of the trees, causing them to fall, and doubtless often to dam up the courses of rivulets, which, percolating among the prostrate trunks, gradually converted them into peat; hence many of the larger peat mosses which occupy so many depressions in the older rocks, including that of the Wealdmoors. Of course this only applies to the inland woods. On the sea-shore there could be no such checked streams, and, in consequence, we find the submerged beds of the Welsh coast covered merely by tidal mud, the substance of the wood remaining intact.

A principal ingredient in peat formed out of oak is tannin. This is a strong preservative of animal and vegetable substances; but its derivative, tannic acid, destroys all calcareous matter, for which reason shells and bones are rarely found in peat of this age. When they have been said to be found there, it has usually been either in the underlying mud, or in an intercalated bed of sand or drift.

It will be observed that in the preceding sketches almost all the important changes on the surface of the earth have been ascribed to alterations in the relative level of the sea and land. It was not, however, intended to exclude the many other, but not less powerful, influences which have been at work ever since dry land first appeared above the face of the waters, shaping and destroying, and again remoulding, its outline. One among the most powerful of these has certainly been the variations of climate. To elucidate these, lies in the province of the sister science astronomy, rather than in that of physical geology, properly so called. Another is the gradual action of those innumerable causes comprehended under the term atmospheric. The study of these divides itself into two branches—the mechanical and the chemical. Under the first head, partaking of the nature of an exact science, may be classed calculations as to the bulk and density of matter, and the amount of force required to overcome a certain amount of resistance, represented by the transported material. Also, as to the application of the mechanical powers, whether it be the wedge, as in the growth of plants, or the inclined plane, as in the removal of drift matter, or the lever. This branch is certainly capable of being brought to a very high degree of exactitude, and it has this advantage, that it may be studied anywhere; in the wood, by the flowing stream, on the hill-side; all these afford ample grounds upon which such calculations might be based. This study scarcely seems hitherto to have met with the consideration it deserves. Secondly, the chemical branch. This beautiful and delicate study is daily advancing. Under the head of chemical geology may be comprehended all the effects of acid, produced by the decomposing of vegetables, the chemical effects of rain and atmospheric erosion, and all allied phenomena. As men's minds are engaged in one or other of these branches of the science, a certain bias will be communicated to them, leading them to attribute all phenomena more or less to the action of those laws which are most continually before them; just as in these slight sketches greater prominence has been unintentionally given to one undoubtedly powerful agent. And, since we are not sufficiently wise or powerful to seize at one grasp the pure and unadulterated truth, it is well that it should be so; for out of these varied shades of opinion the true light must eventually be evolved, just as the combination of the rainbow hues produces the clear and colourless fluid by which we see. Slowly, but surely, is this result obtained. Gradually do the mists of ignorance flit away, and the day-dawn of truth beams upon us; while we, eager but patient seekers, have need daily to practise the lesson which the poet teaches, and, in his words, to—

> Learn to labour and to wait.

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